Exhibit 4

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

CYWEE GROUP LTD.,)
)
Plaintiff,)
) Case No.
vs.) 2:17-CV-00140
) -RWS-RSP
SAMSUNG ELECTRONICS CO., LTD.,)
AND SAMSUNG ELECTRONICS)
AMERICA, INC.,)
)
Defendants.)
________________________________)

DEPOSITION OF
JOSEPH J. LAVIOLA, JR., PH.D.
Orlando, Florida
Wednesday, March 7, 2018

Reported by:
RHONDA HALL-BREUWET, RDR, CRR, LCR, CCR, FPR,
CLR, NCRA Realtime Systems Administrator
JOB NO. 138800

March 7, 2018

8:05 a.m.

Deposition of JOSEPH J. LAVIOLA, JR., PH.D., held at the Doubletree, 12125 High Tech Avenue, Orlando, Florida 32817, before Rhonda Hall-Breuwet, Registered Diplomate Reporter, Certified Realtime Reporter, Licensed Court Reporter (TN), Certified Court Reporter (GA and LA), Florida Professional Reporter, Certified Livenote Reporter, NCRA Realtime Systems Administrator, and Notary Public of the State of Florida.

squeeze it and it'll move and change its shape, right?

Then you can have something like a tennis ball, which is somewhat harder; and you can still squeeze it, but it takes more force to do so. Right?

So depending on the object itself that is nonrigid, it will affect how much force you need to apply to change its shape.

Q. But just in terms of, like, moving an object from Point A -- say, like the front of this table to the end of this table, it doesn't matter -- well, let me ask you, does it matter -- if I have a phone that's on the front of this table and I just push it to the end of this table, does it matter if what's pushing it is a rigid body or a nonrigid body?

MR. RAFILSON: Objection. Form.

A. It only matters if -- it could matter, depending on a number of factors. So if I have a phone and I push it across the table, one end to the other -- right? -- or it's being pushed by an object and that

object is nonrigid, depending on the object, it could affect the motion of the rigid body. But there's lots of variables that would come into play.

BY MR. CHEN:

Q. But -- are you okay?

A. Yeah, I'm fine.

Q. But whether the object that is pushing the phone is rigid or nonrigid is a factor that you have to take into account?

MR. RAFILSON: Objection. Form.

A. If -- if there was an object -- such an object that was rigid or nonrigid and you were, you know, requiring enough force to push a phone from one end of the table to the other, there would be -- the calculations would be different in calculating the collision and the responsive force.

BY MR. CHEN:

Q. Okay. I just want to run a real-world example by you just to make sure I've got the concept right.

A. Okay.

Q. So, like, a steel bar is a rigid

body?

A. Yes.

Q. And, like, a phone is also a rigid body?

A. Uh-huh.

Q. They're both made of metal --

A. Yeah.

Q. -- essentially. So if the force that's affecting the phone and pushing it from one end of this table to the other is that steel bar, that's different than if I just use my arm and I go like -- I push it?

A. The force isn't different. It would be the amount of force that would be needed. So given a rigid body such as a steel bar and you were to hit a phone and move it across the table versus using your hand, there may be a difference in the amount of force needed to move the phone in the same -- the same distance.

Q. Is that the only difference, just the amount of force?

MR. RAFILSON: Objection. Form.

A. At the end of the day, yeah.

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BY MR. CHEN:

Q. Does it matter how complex the movement is? Let me just give you an example.

Like, if it's a steel bar, it's sort of just one point of contact. But if it's, like, my arm, it's sort of my elbow and my wrist, and they're all kind of moving at the same time to affect that force, does that make a difference?

MR. RAFILSON: Objection. Form.

A. No, not really.

BY MR. CHEN:

Q. Why doesn't it make a difference?

A. Because it's still a force that's being applied to the object. You may need to calculate that force a little differently because of -- you have, you know, different moving parts, but it's still a force that is being calculated and acting on the object that is moving.

Q. Well, let's focus on the calculations. How are the calculations different?

A. So you would have to -- so what you're effectively talking about with, for example, an arm is, there are degrees of freedom related to that particular object. Right? So I've got an elbow, so there's a degree of freedom there, a wrist, fingers. And if I was to get a correct calculation of the force, I would have to understand what the forces were that were emanating related to the elbow, the wrist, and the fingers. So it would be a more complex calculation -- right? -- if I was to want to give a truly accurate force that was being applied.

Q. And that's a different calculation than just a steel bar? Like, the steel bar is sort of a simpler calculation?

A. It's not necessarily a different calculation; it's a more complex calculation using the same principles.

Q. Because there's more to take into account because there's degrees of freedom in the wrist?

A. Yeah. I mean, the laws of physics are the laws of physics.

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Q. So these calculations when the -- so when you're saying the force is the same when the object is being affected by a rigid versus nonrigid body, the force is the same, but the calculations are a little different; is that right?

MR. RAFILSON: Objection. Vague.

A. The calculations would be modified to reflect the -- well, it depends. If you're talking about minute details about the force, the calculations might be different. If you're talking about, you know -- it really depends on the level of accuracy that you want to have with the forces that you're trying to calculate.

So on the one hand, if you're trying to be very accurate, extremely accurate, then you would have to take into account some of these other forces that relate to the object that's pushing it. But if you're just trying to, you know, get a general representation of the force that's moving, you know, those could be neg- -- I can't say that word -- negligible.

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And it turns out, actually, that, from the rigid body's perspective, it doesn't really make that much of a difference because the sensor is in the object that's being moved. So it's just going to sense force. Doesn't really care where it comes from.

BY MR. CHEN:

Q. From the rigid body's perspective --

A. Yes.

Q. -- but the calculations that you have to do to --

A. So if I was to calculate the forces of the object that was moving, that was pushing the other object, then there would be some subtleties in how I would do that. If I'm calculating the forces or the accelerations, for example, which are really just forces, from the rigid body's point of view that's being moved, it doesn't really make any difference how that movement is going to measure the force and take that into account as a part of whatever it's doing for calculating the motion of that body.

Q. Are you talking sort of about the

magnitude and force or --
A. Well, magnitude and direction.
Q. Why doesn't it matter in terms of direction?
A. Because the -- if this is my rigid body -- okay? -- and I have sensors in it that are going to measure, for example, forces acting on it -- right? -- it's going to be measured forces from whatever, you know, direction. It doesn't -- there's no relevance to how those forces are being calculated on the object. It's just going to sense the forces that are acting on it. If you're talking about trying to calculate the force -- the forces of the object that is actually moving the body, that's different.
Q. So in terms of the rigid object that has sensors on it, it doesn't know what object is affecting that force?
A. Doesn't matter -- the force or any other -- well, the object will measure whatever quantities that are -- that the sensors in it support.
Q. So it just comes up with a value

regardless of what object is affecting that force?
A. Yes.
Q. And that value tells you nothing about whether the object affecting that force was rigid or nonrigid?
A. That's right.
Q. And it doesn't tell you anything about -- for example, if my arm was affecting that force, it doesn't tell you anything about my wrist or my elbow or my shoulder and all those components that affect that force?
A. No.
Q. It's just a value that comes up in the sensor?
A. Uh-huh.
Q. Turn back to Claim 1. I want to get a sense of the process flow of this claim, if that makes sense.
A. Yeah.
Q. So you have a 3D pointing device that has a housing. There is a printed circuit board enclosed by that housing. What's attached to that housing is a six-axis

sensor?

A. It's not attached to the housing; it's attached to the printed circuit board.

Q. Right. Attached to the printed circuit board.

And that has a rotation sensor that detects angular velocities, and it also has an accelerometer for detecting axial accelerations; is that right?

MR. RAFILSON: Objection. Compound. Objection. Document speaks for itself.

You can answer.

A. Yeah, that's what it says in the claim.

BY MR. CHEN:

Q. And rotation sensors were in the prior art at the time of the invention of the '438 patent; is that correct?

A. Uh-huh.

Q. And so were accelerometers; is that correct?

A. Yes.

Q. And if you turn to the next page on Column 19, it talks about how these first and

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A. Yeah, that's the only place in the patent that actually provides those equations which represent an extended Kalman filter.

Q. So Equations 5 through 11 are the only place in the patent that tell you how to do the enhanced comparison method?

MR. RAFILSON: Objection. Misstates testimony.

A. Actually, the enhanced comparison method requires not just Equations 5 through 11 but, actually, at a minimum, requires Equations 1, 2, 3, and 4.

BY MR. CHEN:

Q. So, at a minimum, what are all the equations that are required to do --

A. At a minimum, 1 through 11.

Q. Is there anything else that's required to do the extended Kalman filter?

A. There are -- as I stated in my declaration, there are things in the -- that anybody of ordinary skill in the art who understand the extended Kalman filter would know that are not explicitly described in the -- in the patent in Equations 5

through -- 1 through 11.
Q. So are those things -- I guess what are those things that a person would know?
A. For example, how to set up the measurement noise, how to set up the process noise, how to initialize the filter or the method, how to represent the process in the measurement models.
Q. So are these specific equations or just setup variables?
A. Yeah. Yeah. The extended Kalman filter is a general framework. So there is -- anyone of ordinary skill in the art would understand that it is a general framework, and, therefore, there are lots of ways to set it up.
Q. And Kalman filters were well-known in the art at the time of the --
A. Yes.
Q. -- invention of the '438 patent, correct?
A. Yeah.
Q. And so were extended Kalman filters?
A. Uh-huh.

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MR. CHEN: Do you want to take a quick --

MR. RAFILSON: Sure. Yeah.

MR. CHEN: -- ten-minute break?

MR. RAFILSON: Sure.

(Break taken from 9:06 a.m. to 9:18 a.m.)

BY MR. CHEN:

Q. Look back at Exhibit 3, which is the '438 patent, and let's take a look at Claims 14 and 19 now. It's the very last page. Take a look at those, and tell me when you're done.

A. (Reviewing document.)

Okay.

Q. So Claims 14 and 19 are identical to each other; is that right?

MR. RAFILSON: Objection. Form. Objection. The document speaks for itself.

A. On initial reading of it just now, they look very similar.

BY MR. CHEN:

Q. Okay. So let's just take Claim 14

to be representative. So Claim 14, like Claim 1, also talks about obtaining a set of angular velocities; is that right?
A. Yeah.
Q. And like Claim 1, it also talks about obtaining a set of measured axial accelerations?
A. Uh-huh.
Q. What is different, though, is that it talks about calculating predicted axial accelerations based on measured angular velocities?
A. Uh-huh.
Q. How do you calculate a predicted axial acceleration?
MR. RAFILSON: Objection. Form.
A. You calculate it -- it's actually in the patent. If you go to Column 12 -- and Column 12 takes -- if you go to Equation 1, it shows how you take the angular velocities to calculate the -- what is called -- known as the second quaternion in the patent, and that quaternion is then used in Equations 2, 3, and 4 to compute to predicted axial

accelerations.

BY MR. CHEN:

Q. Can you run through how this equation works? Let's start with Equation 1.

A. So Equation 1 starts off with -- this is the standard equation, differential equation, for a -- the propagation of a quaternion through time. Okay? And angular velocity represents the derivative of orientation. Okay? So we're taking derivative of orientation, angular velocity, and multiplying it by the initial quaternion, and that is going to give you an updated quaternion. Okay?

If you -- and then once you have that, then you can use the various components of the quaternions, the new quaternion that you calculated, to compute the individual components of the axial accelerations.

Q. So let me just step back. What's a quaternion?

A. A quaternion is a representation for orientation that's comprised of four numbers. The four numbers include a vector,

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three-dimensional vector, and a scale of value to represent an axis and angle.

Q. So what do -- what do converting values into quaternion format allow you to do?

MR. RAFILSON: Objection. Form.

A. They provide a different representation that is somewhat easier to work with under various -- under different circumstances.

BY MR. CHEN:

Q. Can you give me some examples of why it's easier?

A. They're easier to use in the context of matrix vector notation, which is common notation, and tools used in the enhanced comparison method that was described here. They also help to deal with ambiguities that you find in Euler angles, E-U-L-E-R.

Q. What is matrix vector notation?

A. Matrix vector notation is just a notation that is often used where a matrix is a sequence of numbers in -- typically, a two-dimensional column, and a vector is often

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a one-dimensional column with numbers, and you can multiply them together to do various things.

Q. So --

A. You can multiply, add, and subtract, various, you know, mathematical things that you can do with them.

Q. So it's sort of a notation, just allows you to do basic mathematical calculations?

A. Linear-algebra-type mathematics, among other things.

Q. So you said quaternions deal with ambiguities. What kind of ambiguities are you talking about?

A. So Euler angles, for example, go from zero to 360. Zero and 360 are the same value, orientation. So, you know, there's ambiguity there. Quaternions allow you to circumvent that ambiguity by putting it into a form that simply just provides an axis and an angle.

Q. In terms of just orientation, are there any other ambiguities that quaternions

allow you to take care of?

A. That's the principal one.

Q. Are there secondary ones?

A. No. Off the top of my head, I would say that's -- if there are, they're not very common. I'm not aware of them. The primary reason you do this is because of the ambiguities with the nonlinearities of the Euler angles.

THE REPORTER: I'm sorry. The ambiguities of the --

THE WITNESS: Of the Euler angle representation.

BY MR. CHEN:

Q. So the principal reason you use quaternions is to deal with the zero-to-360 ambiguity of the Euler angles?

MR. RAFILSON: Objection. Form.

A. Yeah, that's one of the primary reasons. It also makes it easier to do things like interpolation between orientations.

BY MR. CHEN:

Q. Can you tell me what you mean by

"interpolation between orientations"?

A. So I'm given two orientations, and I want to try to figure out an orientation in between them, you can use -- quaternions can make it somewhat easier to deal with that from a mathematical standpoint.

Q. Can you give me an example of two different orientations and how you would interpolate?

A. Sure. Let's say I have an orientation along some arbitrary axis in space -- okay? -- and there's a rotation about that axis by 30 degrees, let's say, and I have another orientation about another arbitrary axis by 40 degrees and I want to try to understand, for example, how to go from that orientation to the second orientation or I want to try to find an orientation in between them, quaternions make it easier to do that.

Q. So besides the zero-to-360 ambiguity and the interpolation between rotations, is there another reason or another ambiguity that quaternions address?

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MR. RAFILSON: Objection. Form.
Objection. Asked and answered.
You can answer.
A. Yeah. No. That's the main reason.
BY MR. CHEN:
Q. And quaternions are in the prior art at the time of the invention of the '438 patent; is that correct?
A. Yes.
Q. So stepping forward again to the -- calculating the predicted axial accelerations. So the first step is the first quaternion; is that correct?
A. No. Well, yes. You take the first quaternion, which is the prior quaternion, and you use that in combination with the angular velocity to calculate second quaternion.
Q. So what is the first quaternion?
A. The first quaternion is -- if you look at the patent, Figure 7, you'll see -- and number 710, the first quaternion is actually the quaternion from the previous state of the system or potentially the

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initial -- initialized value that you use when you start the filter or the comparison method.

So that's what the first quaternion is. It's from the previous state of the system.

Q. Okay. When you say "previous state," what do you mean by the "state of the system"? What is the state of the system?

A. The "state" is a term that's used to describe where the current process is. So, like, in this particular algorithm, we've got different moments in time that we're talking about, and the state represents a particular point in time.

Q. So where the process is at that particular point in time?

A. It's sort of where it would be considered what -- you know, where the algorithm or the method is at some point in time. So at time T–1, as you can see from the patent, is considered to be the previous state -- right? -- which is really, you know, just -- which is what -- this is a recursive

notation?

A. Yes.

Q. And that gives you an estimated orientation at a new point in time?

A. Yes.

Q. And that's the second quaternion?

A. Yes.

MR. RAFILSON: Counsel, I'd just like to note that there appears to be an issue with the -- the '438 patent, it appears to be generally fine, but some of the -- some of the digits appear to be filled in for some reason. I don't know that it makes a substantive difference, but I just wanted to have that on the record.

MR. CHEN: Yeah. I think it's probably just a printing issue.

BY MR. CHEN:

Q. So now that I have my second quaternion, which is an estimated orientation at a new point in time, I can use the Equations 2, 3, and 4 to calculate a predicted acceleration?

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A. Yes.

Q. So Equation 2 is a calculation of a predicted acceleration along the x-axis?

A. Yes.

Q. And then Equation 3 is the predicted calculation acceleration along the y-axis?

A. Uh-huh.

Q. And then Equation 4 is a prediction of -- predicted acceleration along the z-axis?

A. Yes.

Q. Is what we've been talking about, are those well-known concepts, or were they well-known concepts at the time of the invention of the '438 patent?

MR. RAFILSON: Objection. Form.

A. The standard equations for -- the differential equation for the quaternion and the equations for computing these predicting accelerations are fairly well-known in the field.

BY MR. CHEN:

Q. So Equation 2 would have been well-known in the art at the time of the '438

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patent's invention?

MR. RAFILSON: Objection. Form.

A. Uh-huh.

BY MR. CHEN:

Q. And Equation 3 would have been well-known in the art at the time of the invention of the '438 patent?

MR. RAFILSON: Objection. Form.

A. Uh-huh.

BY MR. CHEN:

Q. And Equation 4 would have been well-known in the art at the time of the invention of the '438 patent?

MR. RAFILSON: Objection. Form.

A. (Nods head.)

BY MR. CHEN:

Q. Is there any other way that the '438 patent discloses how to calculate a predicted acceleration?

MR. RAFILSON: Objection. Form.

A. This represents one potential way to do it. There may be others, but I'm not aware of them.

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BY MR. CHEN:

Q. Does the '438 patent disclose any other potential ways of calculating the predicted acceleration?

MR. RAFILSON: Objection. Form.

A. No, not that I'm aware of.

BY MR. CHEN:

Q. Let's go back to Claim 14, if you will. And, again, just for the record, we're using Claim 14 as being representative of Claim 19 as well.

The very lines -- Column 21, lines 33 to 38, it says, "Comparing the second quaternion in relation to the measured angular velocities . . . of the current state at current time T with the measured axial accelerations . . . and the predicted axial accelerations . . . also at current time T."

A. Yes.

Q. How does the '438 patent disclose doing this comparison?

A. So it discloses it in a number of ways. First, if you go to the patent, Figures 7 and 8, it shows the process by

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which 735 -- it shows how it gets the second quaternion, the measured axial acceleration and the predicted axial acceleration, and then it shows that you compare the two to create a third quaternion. Both 7 and 8 do that.

The patent also mentions how to do this, basically, through Columns 12, 13, and 14, which describe the whole process of going from the first quaternion to the second quaternion, to the measured angle acceleration, predicted axial accelerations, and then combining them together through Equations 5 through 11 to get the updated quaternion.

Q. So in terms of the actual calculations that you would use, which equations would those be?

A. The actual equations? Turns out it's going to be -- the actual equation that will do the comparison is Equation 11.

Q. Is this part of the extended Kalman filter that you were talking about?

A. Yes.

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Q. So Equations 1 through 4 are sort of my process for getting current state and predicted accelerations, and then Equations 5 through 11 are the Kalman filter?

A. Okay. So Equations 1 through 4 and the measured acceleration are going to give you the quaternion, the measured acceleration, and predicted acceleration. And those -- that piece right there will give you data that is necessary to put into Equations 5 through 11, which are the basic equations of the extended Kalman filter. Okay? They're not the only equations -- right? -- because, remember, I said extended Kalman filters are framework, so there are other pieces that are associated with it. Those pieces are being able to get the appropriate data that you need to put into the filter. Okay? Those pieces happen to be Equations 1 through 4 and the measured axial acceleration.

So those pieces, then, can be put into the, quote/unquote, main equations of the extended Kalman filter to get the

understand that -- the process model that is described in Equation 1 would be utilized in Equation 5.

BY MR. CHEN:

Q. So you're saying -- and please correct me again -- that these equations in the '438 patent describe the '438 patent's only disclosure of process model, but a person of ordinary skill in the art would know that there are other process models that you can use?

MR. RAFILSON: Objection. Form. Objection. Misstates testimony.

A. Anyone of ordinary skill in the art would understand that these equations, specifically Equations 5 through 11, are a representative or a exemplary embodiment of an extended Kalman filter and that there are potentially other models that could be used.

BY MR. CHEN:

Q. Are these other models in the '438 patent?

A. No.

Q. So a person of ordinary skill in the

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art would know because there have been other extended Kalman filters used?

A. Uh-huh.

Q. And that's well-known in the art?

MR. RAFILSON: Objection. Form.

A. Yeah. I mean, there's been a lot of -- people have been using extended Kalman filters for a while. So there's a lot of work on it.

BY MR. CHEN:

Q. Do you know when extended Kalman filters came around?

A. To the best of my knowledge, they came around sometime in the '60s.

Q. Okay. So going back to Equation 5, then the left side is x(t\t–1)?

A. Yeah.

Q. What is -- is "t" time?

A. Yes. Well, it's time in integer units. So a lot of times, we don't -- we talk about time as being actual time, you know, minutes and seconds, so on. But in mathematics, we often describe time as simply something that happened previously, something

that happens currently, and something that happens next. Right?

So this is basically saying the state at time given the previous time, the current time given the previous time. So, in other words, it's saying the current state given the previous state.

Q. So is that like one hour, it's more state, prior state --

A. Yeah.

Q. -- next state?

A. Yeah. I mean, in terms of implementing it, you would want to know what the actual time was because it does make a difference.

Q. So is t current state?

A. Yes.

Q. And then t–1 is prior state?

A. Uh-huh.

Q. And then you put that into a function x. What is the function x?

A. The function x, it's not a function, actually. It represents the -- what is known as the state vector.

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And that is, in a sense, a type of sensor fusion?

A. Yes.

Q. Because you're using the angular velocities to create a first quaternion?

A. Second quaternion.

Q. Sorry.

A. Yeah.

Q. Second quaternion?

A. I know it's confusing. First, second, third.

Q. How else does the '438 patent accomplish sensor fusion?

MR. RAFILSON: Objection. Form.

A. Well, it also does it by -- you know, Equation 11 is taking the quaternion that is calculated from the process model, and it's taking the quaternion that was calculated using the predicted and measured accelerations and combining them to get a better estimate of the quaternion.

So in that sense, it's taking those things and fusing them together in a way to give you a better estimate of the quantity of

interest.

BY MR. CHEN:

Q. So when you say there -- it's taking these two quaternions and combining them, like we were talking about before, that means assigning a weight and then choosing which one --

A. Well, you can assign a weight and choose which one you prefer to use or you can assign a weight and combine -- and actually add them together, almost like a weighted average.

Q. And what does Equation 11 do?

A. Equation 11 is -- Equation 11 is -- it's slightly unclear what Equation 11 is doing. But based on the mathematics in it, it is either going to combine the two measurements -- it is combining the two measurements together, the quaternion from the measurement and the quaternion from the process, combining them and outputting that quaternion with the weights from the covariance matrix, or it's going to be computing a new error term that can be used

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to calculate the quaternion.

Either way, you are taking data from different sensors and fusing them together.

Q. I understand the combination, but I think you were saying that combination in this context can mean assigning a weight and choosing which one you believe more or sort of just adding them together, right?

A. I mean, you can add; you can subtract. You know, there's a variety of different ways that you can fuse them together.

Q. So what does Equation 11 actually do?

A. Equation 11 is -- looks like it's assigning weights to each of the individual -- it's assigning weights to the process and model -- the process information and the measurement information, and then using that, it's subtracting the two together, and that is going to give you data which then can be utilized to create that third quaternion.

Q. So it's assigning a weight to the

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some of what you need to plug in, that's taught in Equations 5 through 11?

A. I mean, it gives you, like -- for example, it shows you you need this Q matrix, and it shows you you need this R matrix, right? But it's up to the person implementing it to determine what the best way to do that is. And anyone of ordinary skill in the art would understand that.

Q. So it's the '438 patent gives you sort of a open-ended framework; is that correct?

A. Yes.

Q. And what you add into the framework is what makes it different from a plain and ordinary extended Kalman filter?

A. Yes.

MR. RAFILSON: Objection. Form.

A. It represents a manifestation of the extended Kalman filter. Right? And what you do with it in this makes it different.

Every Kalman filter -- extended Kalman is potentially different depending on how you set it up and what data you have,

what process models and so on and so forth.

BY MR. CHEN:

Q. So it's what you add into the framework is what makes it different?

A. Yes.

Q. And the '438 patent gives you a little bit about what you add into the framework?

A. Gives you most of it.

Q. It gives you most of it in Equations 5 there through 11?

A. Uh-huh.

Q. And some of the --

A. Well, actually, Equations 1 through 11.

Q. Sorry. Equations 1 through 11?

A. Yeah. You have to have Equations 1 through 4 in order to be able to populate Equations 5 through 11. If you don't have that, then you don't know what your process model would be. In some sense, the patent's description of the process model and the measurement that you're getting is more important than Equations 5 through 11

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themselves, because if Equations 5 through 11 are in the standard ordinary skill in the art, people understand. Right? But what the patent is doing is, is describing, you know, how you're actually setting it up with the current framework and the current set of measurements and stuff. That's where the real difference lies in a standard extended Kalman filter in its traditional form.

Q. So Equations 1 through 4 give you the setup that you plug into Equations 5 through 11 that make it different from extended Kalman filter -- oh, sorry -- from, like, a plain, ordinary extended Kalman filter?

A. Well, I mean, to say "plain, ordinary extended Kalman filter," there's no plain and ordinary extended Kalman filter. I mean, Kalman filter -- extended Kalman filter is going to be unique depending on -- every one of them is going to be slightly different, depending on what you want to do with it.

Q. But all the underlying math of the

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extended Kalman filter is known, right?

MR. RAFILSON: Objection. Form. Objection. Vague.

A. So the standard equations, yes, are known, right? It's kind of like -- in programming languages, very often there's -- there's a function in the C programming language called qsort. Okay? And that function runs a sorting routine. It's a well-known sorting routine, right? But in order to use it, you need a comparison function to apply. And any comparison function may be different, right?

So even though you're using the basics of a sorting algorithm, the sorting algorithm is really technically different every time because you're using a different comparison method as input to it and even different data. So in that sense, it is somewhat unique, depending on the parameters that you provided.

In the same vein, we have a set of parameters -- right? -- but not numbers. Right? Some of them are numbers, but some of

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own orientation; is that correct?

A. Yes.

Q. And one of those devices is a 3D pointing device?

A. That's right.

Q. But it also gives other examples like a motion detector; is that correct?

A. Uh-huh.

Q. And it gives a navigation equipment example?

A. Yes.

Q. And it gives an example of a communication device integrated with motion sensors?

A. Uh-huh. That's correct.

Q. So from your definition, what is the difference between a motion detector and a 3D pointing device?

MR. RAFILSON: Objection. Form.

A. I suppose a motion detector is something that will detect motion of something. 3D pointing device is a device that will calculate orientation so that it can be utilized in a variety of different

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ways from -- yeah.

BY MR. CHEN:

Q. This says in the paragraph that there's a number of devices that can accurately calculate their own orientation, and a 3D pointing device is one of them.

A. Uh-huh.

Q. So, for example, just a communication device integrated with sensors, that can calculate its own orientation?

A. Yes.

Q. So what's the difference between that and a 3D pointing device?

MR. RAFILSON: Objection. Form.

A. Well, the 3D pointing device is being used for probably a specific function over the communication device or the motion detector. The motion detector could be simply to detect motion of a person -- communication device, so I know something about where the device is located in the world. The difference is 3D pointing device is actually something that's used in the orientation to support a number of

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activities, including pointing and also understanding -- or providing direction and/or orientation information that can be utilized to render graphical elements on a screen so that they'll move with respect to the device.

BY MR. CHEN:

Q. Can I turn your attention to Exhibit 2, which is your second declaration.

A. Yes.

Q. And can you look at paragraph 96 of your second declaration.

A. Yes.

Q. So in this paragraph, you say, "The '978 patent states 'in order to calculate the resulting deviation, the computing processor 348 may utilize" --

A. Wait a minute. Wait a minute. Wait a minute. Am I looking at the wrong thing here? You said Exhibit 2?

Q. Yeah, the February 23rd.

A. Exhibit 2, the 23rd.

Q. I think that might be Exhibit 1, or I might have my numbers wrong.

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A. I have Exhibit 2 dated 2/23/2018, paragraph 96. "However, a person of ordinary skill in the art would recognize that the enhanced comparison method disclosed in the '978 patent is designed to handle noise and errors that would emanate from moving the 3D pointing device."

Q. Are you looking at paragraph --

A. 96.

Q. 96. Yeah. Right. I just went to the second sentence.

A. Oh. Okay. '978 states, "In order to calculate" -- okay. Yes.

Q. This is talking about using a comparison or algorithm to eliminate the errors of the first, second, and third signal sets. And the first signal set and the second signal set and the third signal set, those are what you get from the rotation sensor, the accelerometer, and the magnetometer?

A. It's hard to say, just like "negligible."

Q. Magnetometer.

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A. Just a quick correction. The order that is presented in the patent is -- first is accelerometer, second is magnetometer, and third is rotation sensor.

Q. Okay. So you use the readings from the sensors, and you utilize the comparison method to eliminate the errors that are kind of inherent in each one of those sensors?

A. Uh-huh.

Q. And then is that comparison method in Equations 5 through 11 the same equations that we've been talking about?

A. Yes.

MR. CHEN: Can you guys give me five minutes to check my notes?

MR. RAFILSON: Sure.

(Break taken from 1:53 p.m. to 2:03 p.m.)

BY MR. CHEN:

Q. So just going back briefly to the '978 patent and this comparison algorithm --

A. Yes.

Q. -- besides Equations 5 through 11, are there calculations needed to do the

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comparison method disclosed anywhere else in the '978 patent?

A. Besides -- okay. So you're asking me is anywhere else besides Equations 5 through 11 a disclosure of the enhanced comparison method '978 patent? The answer to that question is, actually, there's a small addition that's somewhat separate from Equations 5 through 11, and they are Equations 26 through 28.

So Equations 26 through 28 will provide orientation -- an estimate of orientation based on the accelerometer and the magnetometer, given that the device is stationary. So that, in and of itself, provides an additional component to enhance the comparison method. It's an either/or proposition essentially. You can use this or you can use the enhanced comparison method to get the orientation.

Q. It's either/or?

A. Well, the problem is, is that if the device is moving -- well, let me put it to you this way: These equations will work if

the device is stationary, you know, just holding it like this.

Q. And just to clarify, Equations 26 through 28?

A. Yes.

Q. Okay.

A. But if the device is moving and/or we want to use the gyroscope, then the enhanced comparison method would include Equations 5 through 11. So the small little addendum to the enhanced comparison method.

Q. So this is just in the event that the device is not moving and we don't want to use a gyroscope -- let's just do 26, 27, and 28 -- that gives us an estimate of orientation?

A. Yes.

Q. But if the device is moving or we want to use the gyroscope, we have to go back to that extended Kalman filter --

A. Yes.

Q. -- in 5 through 11?

A. Uh-huh.

Q. Is there any other disclosure of the

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'978 patent's enhanced comparison method in this specification?

MR. RAFILSON: Objection. Form.

A. Aside from described -- from using the term enhanced comparison method, the various places throughout the patent and describing what it's for and why it's needed and the Figures 7 and 8, no.

BY MR. CHEN:

Q. So I assume you're being paid an hourly rate for your work?

A. Yes, uh-huh.

Q. What is that hourly rate?

A. 375 an hour.

Q. 375?

A. Yes. 375, not $3.75.

Q. Do you keep track of the hours you work?

A. Yes, I do.

Q. Do you know approximately how much time you've spent so far?

A. Off the top of my head, I would say maybe 70, 80 hours, something like that, at this point.

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A. In the '978 patent, I don't think it needs to be construed; but if it does, it would be construed as a handheld device that includes at least one or more accelerometers and a magnetometer and, optionally, a rotation sensor comprising one or more gyroscopes and uses them to determine deviation angles or the orientation of a device.

Q. Okay. I want to refer you to Exhibit 4. And for the record, what is Exhibit 4 again?

A. That's the '978 patent.

Q. Okay. And what's the title of the -- of Exhibit 4?

A. "3D Pointing Device and Method for Compensating Rotations of the 3D Pointing Device Thereof."

Q. And I'd like to refer you to a portion of text counsel referred you to earlier today. Would you turn to the bottom of Column 3 of Exhibit 4.

A. Okay. Yes.

Q. And do you see the text that refers

to a navigation device, motion detector, or a communication device?

A. Yes.

Q. Would you read that sentence for the record, please.

A. Okay. "In addition, as the trend of 3D technology advances and is applicable to various fields including displays, interactive systems and navigation, there is a significant need for an electronic device, including, for example, a motion detector, a 3D pointing device, a navigation equipment, or a communication device integrated with motion sensors therein, capable of accurately outputting a deviation of such device readily useful in a 3D or a spatial reference frame.

Q. Thank you, Dr. LaViola.

And how, if at all, is a 3D pointing device different from a navigation device?

A. It's not necessarily different. It's -- could be integrated within. In fact, if you look at Figure 6 in the '978 patent, it's a picture of a -- effectively, a smartphone or navigation equipment and was an

exploded diagram that shows an embodiment of electronic device, the present invention, such as a smartphone or navigation equipment, utilizing a nine-axis motion sensor module according to anther embodiment of the present invention.

Q. I'm sorry, Dr. LaViola. What text are you reading?

A. This is Figure 6 on the '978 patent, Column 8, row 37 to 43.

Q. Okay. How, if at all, is a 3D pointing device different from a motion detector?

MR. CHEN: Object to the form.

A. It isn't necessarily different from a motion detector. It can be used as a motion detector.

BY MR. RAFILSON:

Q. How, if at all, is a 3D pointing device different from a communication device?

MR. CHEN: Object to form.

A. It could be used as a motion -- as a navigation device as well, or included within it.

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BY MR. RAFILSON:

Q. Dr. LaViola, I want to clarify my question. I said, "How, if at all, is a 3D pointing device different from a communication device?"

A. Oh, I'm sorry.

MR. CHEN: Object to form.

A. Yes, it could also be included as part of a communication device as well, 3D pointing device.

BY MR. RAFILSON:

Q. I'd like to refer you to Equation 11 of the '438 patent. That's Exhibit 3. So that is -- look at Column 14, please.

A. Yes.

Q. There was some testimony about Equation 11 earlier today, right?

A. Yes.

Q. How, if at all, were you familiar with Equation 11 before this case?

A. I was familiar with the general concept of Equation 11 but not the actual equation itself.

Q. So we talked earlier about the scope

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of the claims. How, if at all, do you believe that the claims require that Equation 11 be used?

A. I don't believe that the -- that it requires Equation 11 to be used at all. It can be used -- there are other equations that are similar that can be used in its place to maintain the enhanced comparison method.

MR. RAFILSON: Thank you, Dr. LaViola. I have no further questions.

REDIRECT EXAMINATION

BY MR. CHEN:

Q. Dr. LaViola, during the most recent break, did you confer with CyWee's counsel, Ari Rafilson?

MR. RAFILSON: I would advise, Counsel, not to disclose the contents of any particular communications. Otherwise, he can discuss generally that we spoke together.

MR. CHEN: So you're saying the contents are not discoverable?

MR. RAFILSON: That is what I'm

C E R T I F I C A T E

STATE OF FLORIDA:

I, RHONDA HALL-BREUWET, RDR, CRR, LCR, CCR, FPR, CLR, NCRA Realtime Systems Administrator, shorthand reporter, do hereby certify:

That the witness whose deposition is hereinbefore set forth was duly sworn, and that such deposition is a true record of the testimony given by such witness.

I further certify that I am not related to any of the parties to this action by blood or marriage, and that I am in no way interested in the outcome of this matter.

IN WITNESS WHEREOF, I have hereunto set my hand this 8th day of March, 2018,

____

RHONDA HALL-BREUWET, RDR, CRR, LCR, CCR, FPR, CLR,
NCRA Realtime Systems Administrator
Shorthand Reporter